QUALITY OF SERVICE APPROACH FOR RISK MANAGEMENT AND COST OPTIMISATION FOR ELECTRICITY NETWORKS

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INTRODUCTION

Commercial and competitive pressures continue to reduce the inherent safety margins that traditional management decision making has depended on to assure high performance network operation. This has increased operational risk management?, yet expenditure is expected to continue to be reduced, at a time when the regulator is demanding improved performance. Traditional methods of budgeting, prioritising projects, and deciding on the timing and extent of additional maintenance work are based on insufficient information for informed decisions – and the consequences of failure can be catastrophic. An approach for making CAPEX/OPEX decisions based on the impact on the expected quality of service provided, proved to be a good tool for performance improvement with management risk control in the longer term with confidence while minimising cost in the short term.

USING OBJECTIVE TOOLS TO OPTIMISE SPEND AND MANAGE RISK/RELIABILITY

Many utilities cannot adequately measure the reliability inherent in their assets, nor can they quantify the risks associated with changing maintenance or construction standards. For many companies, the annual investment planning process is primarily one of negotiation around a constrained budget.

In the absence of a scientific approach, the investment allocation process will always return a sub-optimal solution. If utilities cannot quantify the reliability impact of each maintenance and engineering intervention, it cannot measure or manage asset reliability - or minimise expenditures without increasing the risk of failure.

We have discovered cases where actions are performed in networks that have a negative impact on quality of service; clearly these must be identified and eliminated.

For this reason, it is necessary to identify the impact of each intervention on the quality of service so as to orient available budget towards those that produce a greater impact, leaving out those with a low incidence or negative impact.

Using objective methodologies can bring significant improvements to the utilities including:
- Cost reductions in the range of 10% to 30%
- SAIDI improvements without expected additional capital outlays
- Savings in construction costs in the order of 15% to 25%.

METHODOLOGY

The CAPEX/OPEX method focuses on quantifying the reliability that will result from various actions – and simulate performance into the future. This involves modelling several variables which combine analyses of the network flow characteristics, the achieved reliability (deterministic analysis) and the most likely result over time (probabilistic analysis) to quantify reliability. This approach is based on the premise that overall network performance is determined by the performance of individual components and the way the components are configured. Figures 3 to 10 illustrates how this methodology is used to obtain a forecast of the network’s reliability.

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Modelling tools

The analysis is performed through a detailed modelling of the networks; identifying the various elements of protection and operation as shown in the outline below in Fig.4.

The conceptual outline of the modelling process was indicated in Fig.3, where the link between expenditure and expected performance was explained. The following points conceptually describe the various modules that integrate the modelling process.

Conceptual preventative maintenance module. The network characteristics and maintenance policies of each of network components, define the failure rate and associated cost. This is reflected in the modelling process indicated in Fig.6.

In practice we don’t use continuous functions but discreet functions and therefore the resulting graphs are curves at regular intervals as indicated in the following Figure.

The many maintenance actions determine the different network components producing a relation between the failure rates and the maintenance actions that could be idealized as a continuous curve. The combination of all the possibilities for the totality of the network components becomes a probabilistic curve that represents the possibility of obtaining an specific level of quality of service.

Conceptual corrective maintenance module. The actions associated with corrective maintenance depend on the network characteristics, the operative policies and on the failure rates of the same. Furthermore, depending on the intervention policies employed to solve the detected inconveniences, different service recovery times and associated costs will be obtained. This is reflected in the
modelling process shown in Figure 8.

**Figure 8 – Corrective maintenance module**

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<table>
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<tr>
<th>INPUT DATA</th>
<th>AvgFailureRate = \sum f(action_i)</th>
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</thead>
<tbody>
<tr>
<td>Network Characteristics</td>
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<tr>
<td>Topology</td>
<td></td>
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<tr>
<td>Size</td>
<td></td>
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<tr>
<td>Equipment</td>
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<tr>
<td>Technology</td>
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<td>Operating Policy</td>
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Corrective Maintenance Actions

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**Quality of service module.** The expected quality of service is obtained by the maintenance actions carried out taking into consideration the network characteristics and their adequate modelling as input information, the failure rates of each of the components as a function of the preventive maintenance actions, and the average service reposition time. The expected quality can be obtained for different additional network voltage levels as indicated in Figure 9.

**Figure 9 – Quality of service module**

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<table>
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<th>INPUT DATA</th>
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<td>Equipment</td>
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Quality of Service Module

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**RESULTS**

This approach is used in the Americas, enabling network operators to optimise the cost/performance trade-off, minimise performance-related penalties/risks, and to manage regulatory expectations. For example, in Peru, it was applied to help two major utilities to agree individual feeder targets with the regulator, and achieve those targets within 1 year through improvements in maintenance, operations and minor capital investments. Predicted SAIFI and SAIDI for an area in Lima/Perú is shown in the figure below.

These tools have been developed to assist electricity Network Managers to identify the expenditures levels necessary to achieve required quality of service levels – with confidence. These objective tools model the performance resulting from various actions, and provide the insight necessary for making
informed decisions based on sound engineering data, and factual performance inputs. Management can minimise risk whilst providing a better performance despite fiscal constraints, and identify areas where investment is going to be necessary in the future. These sophisticated and proven tools are available for electricity network operators to use in the continuing endeavour to optimise system capabilities and performance while minimising cost at the same time. Identifying high risk areas and the consequences of various actions, enables the whole Management team to work together to optimise cost and performance. In this way, most Network companies can continue to improve performance and manage risk in the longer term with confidence while minimising cost in the short term.

REFERENCES

